



# Course Specification

— (Postgraduate)

<b>Course Title:</b> Functional Analysis (I)
<b>Course Code:</b> 202581-3
<b>Program:</b> Master of Pure Mathematics
<b>Department:</b> Mathematics and Statistics
<b>College:</b> Faculty of sciences
<b>Institution:</b> Taif university
<b>Version:</b> 1
<b>Last Revision Date:</b> 2023



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## A. General information about the course:

### 1. Course Identification:

1. Credit hours: ( 3)h

### 2. Course type

A. University College Department Track

B.  Required  Elective

3. Level/year at which this course is offered: Second level

### 4. Course general Description:

Some topics in functional analysis must be discussed such as:

Linear Spaces -Normed linear spaces-Hilbert spaces-bounded linear operators and functionals-The Hahn-Banach theorem and its consequences.

5. Pre-requirements for this course (if any): None

6. Pre-requirements for this course (if any): None

### 7. Course Main Objective(s):

1. Study Linear spaces.
2. Study normed linear spaces.
3. Study Hilbert spaces.
4. Study Linear operators and functionals.
5. Study Hahn-Banach theorem and its consequences

### 2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	√	100%
2	E-learning		
3	Hybrid <ul style="list-style-type: none"> <li>• Traditional classroom</li> <li>• E-learning</li> </ul>		
4	Distance learning		



### 3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	45
2.	Laboratory/Studio	NA
3.	Field	NA
4.	Tutorial	NA
5.	Others (specify).....	NA
<b>Total</b>		<b>45</b>

### B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
<b>1.0</b>	<b>Knowledge and understanding</b>			
1.1	<b>Recognize</b> fundamentals concepts of certain operators related to linear spaces.	K1	Lectures, group discussion	Exams, Quizzes, Assignments
1.2	<b>Describe</b> Hilbert Spaces.	K3	Lectures, group discussion	Exams, Quizzes, Assignments
...				
<b>2.0</b>	<b>Skills</b>			
2.1	<b>Give some</b> Bounded linear operators and functional.	S1	Lectures, group discussion	Exams, Quizzes, Assignments
2.2	<b>Demonstrate</b> properties Hahn-Banach Theorem and its Consequences .	S5	Lectures, group discussion	Exams, Quizzes, Assignments
...				
<b>3.0</b>	<b>Values, autonomy, and responsibility</b>			
3.1	<b>Participate</b> basic properties linear and normed spaces.	V1	Lectures, group discussion	Exams, Quizzes, Assignments





Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.2	<b>Give</b> responsibility for learning the Hahn-Banach theorem and its consequences	V2	Lectures, group discussion	Exams, Quizzes, Assignments
...				

### C. Course Content:

No	List of Topics	Contact Hours
1.	General and basic properties of Metric spaces, Vector space, Normed space, and further properties of Normed spaces	3
2.	Linear spaces, Bounded and Continuous Linear Operators , Linear Functionals, Linear Operators and Functionals on Finite Dimensional Spaces	3
3.	Linear Operators and Functionals on Finite Dimensional Spaces, Normed Spaces of Operators, Dual Space.	3
4.	Inner Product Space, Hilbert Space , Further Properties of Inner Product Spaces, Orthogonal Complements and Direct Sums , Orthonormal Sets and Sequences	3
5.	Representation of Functionals on Hilbert Spaces, Hilbert-Adjoint Operator, Self-Adjoint, Unitary and Normal Operators	3
6.	Fundamental Theorems for Normed and Banach Spaces, Zorn's Lemma, Hahn-Banach Theorem, Application to Bounded Linear functionals on $C[a, b]$ , Adjoint Operator	3
7.	Reflexive Spaces, Uniform Boundedness Theorem, Strong and Weak Convergence, Convergence of Sequences of Operators and Functionals , Weak* Convergence.	3
8.	<b>Midterm exam</b>	3
9.	Open Mapping Theorem, Closed Linear Operators. Closed Graph Theorem	3
10.	Spectral Theory of Linear Operators in Normed Spaces, Spectral Theory in Finite Dimensional Normed Spaces.	3
11.	Basic Concepts, Spectral Properties of Bounded Linear Operators.	3
12.	Compact Linear Operators on Normed Spaces and Their Spectrum	3
13.	Unbounded Linear Operators and their Hilbert-Adjoint Operators, Hilbert-Adjoint Operators, Symmetric and Self-Adjoint Linear Operators Closed Linear Operators and Closures	3
14.	Banach Algebras. Further Properties of Banach Algebras	3
15.	Further Properties of Banach Algebras.	3
<b>Total</b>		<b>45</b>





## D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes and HomeWorks	Continues	10 %
2.	Midterm exam 1	8 <sup>th</sup> - 9 <sup>th</sup>	20 %
3.	Final exam	16 <sup>th</sup>	70%
...			

\*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

## E. Learning Resources and Facilities:

### 1. References and Learning Resources:

Essential References	<b>Erwin Kreyszig, Introductory Functional Analysis with Applications, Willy , 1978.</b>
Supportive References	<b>Ovchinnikov, Sergei. <i>Functional analysis: an introductory course.</i> Springer, 2018.</b>
Electronic Materials	<a href="https://docs.ufpr.br/~eidam/2019/2/CM075/Kreyszig.pdf">https://docs.ufpr.br/~eidam/2019/2/CM075/Kreyszig.pdf</a>
Other Learning Materials	None

### 2. Educational and Research Facilities and Equipment Required:

Items	Resources
<b>facilities</b> (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms
<b>Technology equipment</b> (Projector, smart board, software)	Data show, Blackboard
<b>Other equipment</b> (Depending on the nature of the specialty)	None

## F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
<b>Effectiveness of teaching</b>	Students, Program Leader	Direct& Indirect
<b>Effectiveness of students assessment</b>	Faculty, Program Leader	Direct
<b>Quality of learning resources</b>	Students, Faculty	Indirect
<b>The extent to which CLOs have been achieved</b>	Faculty	Direct& Indirect
<b>Other</b>		





**Assessor** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

**Assessment Methods** (Direct, Indirect)

### G. Specification Approval Data:

<b>COUNCIL /COMMITTEE</b>	Department Council
<b>REFERENCE NO.</b>	
<b>DATE</b>	October 2023

قسم الرياضيات والإحصاء  
Mathematics and Statistics  
Department

